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June 28, 2016

By ECFS

Marlene H. Dortch
Office of the Secretary
Federal Communications Commission
455 12th Street, S.W.
Washington, DC 20054

Re: WC Docket Nos. 16-143, 05-25, RM-10593; *Assessment of the FCC's Proposed Options for the Special Access Price Cap X-Factor*; Prepared By Drs. Mark E. Meitzen and Philip E. Schoech of Christensen Associates

Dear Ms. Dortch:

Enclosed for filing in the above-referenced proceedings is the *Assessment of the FCC's Proposed Options for the Special Access Price Cap X-Factor*, prepared by Drs. Mark E. Meitzen and Philip E. Schoech of Christensen Associates.

Respectfully submitted,

Kyle J. Fiet

Enclosure



Assessment of the FCC's Proposed Options for the Special Access Price Cap X-Factor

By

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June 28, 2016

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ASSESSMENT OF THE FCC'S PROPOSED OPTIONS FOR THE SPECIAL ACCESS PRICE CAP X-FACTOR

Mark E. Meitzen, Ph.D. and Philip E. Schoech, Ph.D.
Christensen Associates

June 28, 2016

INTRODUCTION

We are Dr. Mark E. Meitzen and Dr. Philip E. Schoech of Christensen Associates, an economic consulting and research firm in Madison, WI. We have been asked by AT&T to provide an evaluation of the three options the Federal Communications Commission (FCC) has proposed for determining the X-factor for price cap regulation of non-competitive special access services by price cap local exchange carriers in its Further Notice.¹

Christensen Associates has a long history of analyzing incentive regulation in the telecommunications industry and the measurement of industry total factor productivity (TFP). The firm has its roots in Professor Laurits Christensen's 1970s testimony in the AT&T divestiture case² and his measurement of Bell System productivity.³ In addition to the landmark study of the Bell System, Christensen Associates has performed productivity studies submitted in the FCC's price cap proceedings of the 1980s and 90s, and has performed productivity studies that have been submitted in numerous state price cap proceedings. In addition to telecommunications, Christensen Associates has performed total factor productivity studies for a number of other industries, including electric utilities, railroads, cable television, and postal. In fact, Christensen Associates produces the official measurement of total factor productivity for the U.S. Postal Service that is reported annually to Congress.

Mark E. Meitzen is a vice president at Christensen Associates, where he has been employed since 1990. Prior to that, he was a regulatory economist at Southwestern Bell Telephone Company in St. Louis, Missouri. At Christensen Associates, he has consulted with firms in a number of network industries, including the telecommunications, electricity, postal, and railroad industries. He has co-authored a number of productivity studies conducted by Christensen Associates, including analyses performed for former Regional Bell Operating Companies, the United States Telephone Association, the National Cable Television Association, and the Stentor companies in Canada. He has analyzed incentive regulation issues for various network industries including the telecommunications, electric utility, and postal industries, and directed the Christensen Associates team that analyzed incentive regulation options for Peru's transition to a privatized telecommunications industry. Dr. Meitzen also directed Christensen

¹ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593.

² Testimony of Laurits R. Christensen *United States v. AT&T*, Civ. Action No. 74-1698 (D.D.C., filed November 20, 1974).

³ Laurits R. Christensen, Dianne Cummings Christensen, and Philip E. Schoech, "Total Factor Productivity in the Bell System," September, 1981.

Associates' analyses of cost proxy models for universal service and has also conducted a number of TELRIC studies for costing unbundled network elements.

Philip E. Schoech is a vice president at Christensen Associates, where he has been employed since 1976. At Christensen Associates, he has consulted with firms in a number of network industries, including the telecommunications, electricity, postal, and railroad industries. He has co-authored a number of productivity studies conducted by Christensen Associates, including the landmark Bell System productivity analysis produced in 1981. He has analyzed incentive regulation issues for various network industries including the telecommunications, electric utility, and postal industries. Dr. Schoech currently oversees the measurement of total factor productivity for the United States Postal Service, which the Postal Service includes in its Annual Report to Congress and files with the Postal Regulatory Commission.

BACKGROUND

In its Further Notice, the FCC proposes to apply a form of price cap regulation to business data services (BDS), that are primarily legacy TDM-based DS1 and DS3 special access services, in areas that are deemed to be not competitive.

[T]he Commission proposes to apply a price cap regime to the provision of TDM services in non-competitive markets ... ⁴

The principal price cap services are TDM business data services (i.e., DS1 and DS3 services).⁵

The Further Notice describes these TDM-based services as follows:

Circuit-based BDS uses the TDM protocol, which combines multiple individual communications between two locations over a single channel by dividing the channel into distinctly allocable time segments, i.e., capacity is reserved "in the form of dedicated time slots." TDM services are considered a legacy technology and consist primarily of DS1s and DS3s with symmetrical capacities of 1.5 Mbps and 45 Mbps, respectively. To increase bandwidth, providers must either bond multiple circuits together or deploy new technology.⁶

Incumbent LECs are the primary facilities-based suppliers of legacy TDM services and increasingly provide packet-based BDS. ... Their legacy networks consist of copper to locations (i.e., the

⁴ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 8.

⁵ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 351.

⁶ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 45.

same medium used to create telephone systems in the late nineteenth century), central offices, and circuit switches. But over the past few decades, incumbent LECs have increasingly updated their copper networks with fiber and IP-based architecture to improve system capacity to handle the ever increasing demand for data services, and to gain efficiencies. Modernizing this legacy infrastructure requires significant investment by the incumbent LECs.⁷

In contrast to this legacy technology for business users, which provides guaranteed speeds and service levels, the FCC notes how current mass-market internet-based technologies differ with respect to cost characteristics:

BDS is distinctly different from the mass marketed, “best efforts” broadband Internet access services (BIAS) provided to residential end users, ... As such, BDS tends to cost substantially more than “best efforts” services and offered to businesses, non-profits, and government institutions that need to support mission critical applications and have greater demands for symmetrical bandwidth, increased reliability, security, and service to more than one location.⁸

DESCRIPTION OF FCC’S PROPOSED X-FACTOR ALTERNATIVES

Abstracting from “exogenous” adjustment factors, the FCC’s price cap formula has two basic elements: (i) a measure of overall inflation, given by growth in the Gross Domestic Product Price Index (GDP-PI); and (ii) the X-factor. Thus, the basic price cap formula is given by:

(1) Allowed Price Growth = GDP-PI growth - X

The economic literature shows that the applicable X-factor for the GDP-PI inflation factor, absent any adjustments for exogenous cost changes or other ad hoc additives like the former consumer productivity dividend (discussed below), is the sum of two components: (i) the difference between industry TFP growth and economy-wide TFP growth, and (ii) the difference between economy-wide input price growth and industry input price growth:

(2) X = (industry TFP growth – economy-wide TFP growth) + (economy-wide input price growth – industry input price growth)

⁷ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 52.

⁸ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 13.

However, GDP-PI growth is related to economy-wide input price growth and economy-wide TFP growth in the following way:

(3) GDP-PI growth = economy-wide input price growth – economy-wide TFP growth

Therefore, from (2), one can substitute GDP-PI growth for the difference in economy-wide input price growth and economy-wide TFP growth in the X-factor formula, yielding the formula that provides the framework for the FCC's computation of the X-factor under its proposed alternatives:⁹

(4) X = GDP-PI growth – industry input price growth + industry TFP growth

Consequently, one can compute an X-factor value from measured rates of industry TFP growth, industry input price growth, and GDP-PI growth. The Further Notice recounts that, up until the time of the 2000 *CALLS Order*, the FCC's X-factor was based on a formula such as (4) with the differential between industry and economy-wide TFP growth as the basis of the X-factor, to which, the 1997 *Price Cap Review Order* added the input price differential.¹⁰ In the original price cap order for AT&T, the X-factor was established based on a review of telecommunications industry TFP studies, including that of Professor Christensen and his testimony in the AT&T divestiture case.¹¹ The X-factor in the original LEC price cap plan also considered these studies of telecommunications industry TFP, supplemented by staff studies of historical LEC inter- and intrastate price performance.¹²

A consumer productivity dividend (CPD) was an additive to the X-factor in the original AT&T and LEC price cap plans, "To ensure that ratepayers are better off under price cap regulation and to pass on directly to them gains resulting from efficiency improvements that we expect will result under a price cap system."¹³ The CPD was also retained in the LEC price cap plan when the FCC eliminated the earnings sharing requirements of the plan.¹⁴ Given that the current proposed price cap plan for BDS represents neither a transition to a more incentivizing regulatory regime nor a relaxing of a regulatory constraint, the addition of a CPD in this case, in our opinion, is not appropriate.

Subsequent FCC decisions reinforced the notion that the X-factor be based on industry TFP growth (and input price growth) as evidenced by the FCC's declaration that:

⁹ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 405.

¹⁰ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, paras 359-360.

¹¹ For example, see Federal Communications Commission, Report and Order and Second Further Notice of Proposed Rulemaking, CC Docket No. 87-313, April 17, 1989, paras 198-239.

¹² Federal Communications Commission, Second Report and Order, CC Docket No. 87-313, October 4, 1990, paras 74-102.

¹³ See Federal Communications Commission, Report and Order and Second Further Notice of Proposed Rulemaking, CC Docket No. 87-313, April 17, 1989, paras 248-252, 727-729.

¹⁴ See Federal Communications Commission, Fourth Report and Order in CC Docket No. 94-1 and Second Report and Order in CC Docket No. 96-262, May 21, 1997, paras 122-127.

We find that TFP is a more accurate measure of LEC productivity [as opposed to the Historical Price Method] because it is based on incumbent LECs' actual outputs and inputs.¹⁵

In this decision, the FCC also addressed data availability issues and expressed that adequate publicly available data were available to conduct the required TFP studies:

We find that the record demonstrates that publicly available data can now provide an adequate basis for TFP analysis.¹⁶

In the current proceeding, given the values of GDP-PI growth, the FCC's three proposed X-factor calculation alternatives employ different approaches to determine the values of industry TFP growth and industry input price growth: (1) the KLEMS model, (2) the Connect America Cost Model supplemented with several input price assumptions proposed by the FCC staff, and (3) the Connect America Cost Model supplemented with several input price assumptions based on proprietary data proffered by a largely rural non-price cap ILEC, TDS.

Method One – KLEMS Model

The first approach used by the FCC to estimate an X-factor is based on the KLEMS database, developed by the U.S. Bureau of Labor Statistics (BLS).¹⁷ The five components of KLEMS are capital (K), labor (L), energy (E), non-energy materials (M), and purchased services (S). The BLS developed the KLEMS database as part of its mission to measure total factor productivity in different sectors of the U.S. economy. (The BLS uses the term multifactor productivity instead of total factor productivity, but these are conceptually equivalent.) The KLEMS database is developed using rigorous total factor productivity principles and is a valid source of measuring total factor productivity and input price trends for various industries.

The FCC has used KLEMS data for the Broadcasting and Telecommunications industry (NAICS industries 515 and 517) for estimating industry TFP and input price growth to determine the X-factor. Among the industries for which BLS provides TFP estimates, this is the most detailed industry that contains telecommunications. Indeed, telecommunications accounts for roughly 82% of the combined industry's revenues and well over 90% of the combined industry's assets.¹⁸ Therefore, the TFP developed from this combined industry data should most closely track that of its predominant component, the telecommunications industry.

¹⁵ Federal Communications Commission, Fourth Report and Order in CC Docket No. 94-1 and Second Report and Order in CC Docket No. 96-262, May 21, 1997, para 23.

¹⁶ Federal Communications Commission, Fourth Report and Order in CC Docket No. 94-1 and Second Report and Order in CC Docket No. 96-262, May 21, 1997, para 20.

¹⁷ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, paras 406-407.

¹⁸ See: <https://www.census.gov/econ/qfr/index.html>, and https://www.census.gov/econ/qfr/mmws/current/qfr_tabs_f.xls.

Method Two – Connect America Cost Model

The Connect America Cost Model (CACM) is a cost proxy model, based on a scorched node approach, and assumes a network that is instantaneously constructed with only forward-looking, least-cost technologies. The FCC has used the CACM to provide a census-block level estimate of the costs of providing a voice and broadband-capable network for determining the Connect America Fund support to provide broadband services.¹⁹ As described by the FCC:

The CACM was developed to estimate the costs of a mass market residential broadband fiber-to-the-premise network that also is used to provide telephone service, and was built to also provide business data services. Consequently, it is essentially a model of the costs of an incumbent LEC supply, but with a focus on residential rather than business data services.²⁰

Despite the FCC's description, the claim that the CACM was built to also provide business data services is not accurate. According to the CACM model documentation, "the model deploys Special Access fiber to a business location."²¹ That is, the model assesses the amount of fiber required to serve assumed BDS-related locations solely for the purpose of determining the level of cost sharing to be used in the development of the last-mile fiber cost for the mass-market locations. Aside from this allocation function, the model develops no other BDS resource quantities, including fiber quantities necessary for BDS middle-mile or interoffice fiber. In particular, it is our understanding that none of the important resources necessary for providing special access services, such as engineering, electronics, switching/routing, service provisioning and all BDS-related overhead activities are either quantified or costed by the CACM.

From gross cost share results developed from the CACM (which models only the cost of mass-market fiber to the premise (FTTP) BIAS services), the FCC proposes to add a jumble of information that it posits may represent actual input prices paid by ILECs for BDS inputs. It then proposes to combine "high" and "low" estimates for industry input price growth with an estimate of national TFP growth obtained from a study of economy-wide productivity conducted by the Federal Reserve Bank of San Francisco.²² This national TFP figure is then combined with GDP-PI growth and the input price growth to develop a BDS X-factor pursuant to equation (4), above.

¹⁹ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 408.

²⁰ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 409.

²¹ Connect America Cost Model (CACM) Model Methodology, December 22, 2014, p. 21.

²² Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, Appendix C, para 11.

Method Three – Connect America Cost Model with TDS Data

Method Three also uses the CACM, but supplemented with data from TDS Telecom (TDS), a largely rural non-price cap incumbent LEC. The FCC notes that using the TDS data required some mapping of cost categories:

The TDS categories, other than those for labor and real estate, were not at the same level of detail as in the CAPM calculations. This required that the TDS categories for switching and transmission be mapped to the remaining eight CACM categories.²³

As with Method Two, Method Three relies on a study of economy-wide productivity conducted by the Federal Reserve Bank of San Francisco as a proxy for industry TFP growth in equation (4) above.

ASSESSMENT OF FCC’S PROPOSED ALTERNATIVES

In this section, we perform an economic assessment of the FCC’s three methods as potential measures of the proposed special access X-factor. As is evident from the discussion below, the KLEMS-based approach comes closest to the FCC precedent of basing the X-factor on industry-specific TFP and input prices consistent with the TFP estimates (and not relying on an economy-wide productivity study and disjointed input prices), as well as its stated preference for relying on publicly-available data. In contrast, the other two methods have little consistent economic theory behind them, follow rather convoluted methods of analysis, and employ idiosyncratic data.

Method One – KLEMS Model

In computing TFP, the BLS uses methods that are well accepted for productivity measurement, and are very similar to those that we have used in our measurement of productivity for the telecommunications industry as well as other industries. TFP is the ratio of total output to total input. Total output is obtained by constructing constant dollar measures from the values of sales and Producer Price Indexes that capture price trends for the various services provided by an industry. The different constant dollar measures are then aggregated together using a Tornqvist index formula.

The BLS constructs total input from quantity measures for capital, labor, energy, materials, and services. This breakdown is more detailed than what is found in many industry productivity studies that typically distinguish only three inputs: capital, labor, and materials (a combination of energy, materials, and services). The BLS capital input measurement methods are similar to what we have used in our studies and are based on a rigorous theory of capital. The labor input measure is based on the number of workhours. The energy, materials, and services input

²³ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 411.

measures are obtained by dividing the costs associated with these inputs by Producer Price Indexes that reflect the inputs used in the provision of broadcasting and telecommunications services. In this way, the measurement of these inputs is more precise than studies that use a broader materials input measure that is developed by using the GDP-PI to reflect the price of materials input. The total input measure is constructed as a Tornqvist index of the capital, labor, energy, materials, and services input measures.

As part of its measurement of total input, the BLS develops price indexes for the five inputs. The FCC also uses these price indexes to compute an industry input price measure. However, as explained in the Appendix, the method used by the FCC to aggregate these five input price measures is not conventional and is not consistent with the indexing methods used by the BLS. In evaluating the X-factors associated with this data base, we revise the FCC's calculated industry input price calculation to be consistent with BLS methods and accepted economic theory.

Although the industry being measured by the BLS is broader than telecommunications, telecommunications accounts for over 82% of the combined industry's revenues and over 90% of its assets.²⁴ Consequently, the BLS results are quite applicable to the telecommunications sector.

X-Factor Calculations

Using the BLS formula for constructing the industry input price index instead of the FCC-proposed formula, Table 1 shows the original and corrected X-factor estimates (based on the original and corrected input price growth series) for the different periods analyzed by the FCC.

Table 1
X-Factor Based on KLEMS Data, with Original and Corrected Input Price Series

Year Range	GDP-PI	Industry TFP	Original Industry Input Price Index	Corrected Industry Input Price Index	Original X-Factor	Corrected X-Factor
1997-2013	1.98%	1.73%	0.96%	1.40%	2.75%	2.31%
1997-2003	1.77%	-0.03%	-1.47%	-0.28%	3.21%	2.02%
2005-2013	1.90%	1.15%	1.20%	1.10%	1.85%	1.95%

The corrected results for these different ranges of years are remarkably stable and consistent with X-factor calculations that have been derived from other telecom total factor productivity studies.

²⁴ Based on total year 2015 data reported by the United States Census Bureau in "Quarterly Financial Report for Manufacturing, Mining, Trade, and Selected Service Industries, 2016 Quarter 1," issued June 2016. Available at <https://www.census.gov/econ/qfr/index.html>, and https://www.census.gov/econ/qfr/mmws/current/qfr_tabs_f.xls.

To determine the appropriate forward-looking X-factor from historical data, it is important to balance the need for stability in the X-factor number with basing the results on recent productivity and market trends. Using a shorter period will be better at capturing recent trends, but it is possible that large year-to-year variations in productivity over a short period may lead to an unstable X-factor projection. On the other hand, using a very long period may produce a more stable series but would include stale data that are likely no longer relevant to forward-looking productivity. In our opinion, using the period 2005-2013 (which includes eight full years of data) in setting the X-factor appropriately balances these two considerations²⁵.

Finally, the use of industry-wide productivity growth in the X-factor for particular services has established precedent as the FCC has used such a measure in its price cap plans for LEC interstate access and many state price cap plans also relied on total factor productivity measures.²⁶ Because of the significance of joint and common costs in the provision of telecommunications services, partial productivity measures for a subset of services generally are not uniquely defined from an economic perspective. However, given that BDS is largely provided with legacy technologies and demand growth for services using these technologies is declining relative to the total bundle of services provided by current telecommunications plant, it is likely that telecommunications industry-wide TFP growth represents an upper bound for the TFP growth realized by BDS services.

Method Two – Connect America Cost Model

Method Two relies on cost shares implied by the CACM, a cost proxy model, to help develop estimates of input price growth for the X-factor; and an economy-wide measure of TFP growth to represent telecommunications industry TFP growth. Aside from being a jumble of data from disparate sources, we believe a fundamental weakness of this method (and also Method Three) is its reliance on a cost proxy model as the basis for establishing input price growth for the X-factor. In this section, we first provide a general overview of cost proxy models and then discuss specific shortcomings of the CACM for this particular application.

Overview of Cost Proxy Models

The CACM is a scorched node proxy model that instantaneously places a new uniform network using the existing wire center locations and cable routes of the incumbent provider using forward-looking, least-cost technologies. In this approach, the efficient hypothetical firm will provide a particular set of mass market services (here, best-effort FTTP BIAS) unconstrained by any sunk investment and therefore unconstrained by past decisions about its network investments and particular customer base. This firm starts with a “blank slate” aside from wire center locations and customer locations, such as housing units and small businesses (which is referred to as the “scorched node” approach). It is then assumed that the firm instantaneously

²⁵ Note further, that to the extent the ILEC X-factor exceeded 2.02% over the 1997-2003 period, this suggests that ILEC price-capped BDS rates coming out of this period may have been excessively constrained by regulation.

²⁶ In fact, the FCC addressed the issue of an interstate-only productivity factor and rejected it in CC Docket no 94-1. See Federal Communications Commission, Fourth Report and Order in CC Docket No. 94-1 and Second Report and Order in CC Docket 96-262, paras 109-112.

constructs a network with the capability to accommodate specified demand at all customer locations (here, a best-effort fiber BIAS line with voice service capability). Costs are then stated to be the average cost of a line within this expansive network.

This approach to estimating the costs of an instantaneously efficient firm represents a static view and does not reflect the dynamic efficiency path of an actual firm – and certainly not the dynamic efficiency of a firm that has served a changing set of customer locations and services over previous years. Actual firms will generally deviate from this hypothetical static standard because of they have in-place networks serving large numbers of current customers at an idiosyncratic set of locations, because they face uncertainty and company budget constraints. Further, the telecommunications industry is capital intensive and has a rapid rate of technological change. Finally, because of its instantaneous approach, proxy model costs and input prices are observed only at an instant in time and, thus, the model does not generate a history or time series for costs, cost shares, or input prices.

The efficient design of actual networks, which consist of a blend of technologies, in specific geographic locations is likely to vary from those generated by the broad assumptions contained in the proxy model network design. For example, the CACM assumes that all mass-market customers, including small business locations, are served with a fiber to the premise, whereas an actual LEC network will be a blend of FTTP and copper-based technologies. This makes it very difficult for generic proxy models to adequately capture the true cost characteristics of efficiently-designed actual networks. While proxy models may be useful for determining relative cost relationships between high-cost and low-cost areas for purposes of allocating a given size universal service fund –e.g. the CACM was designed to estimate the cost of providing mass-market broadband using FTTP technology for the purpose of allocating Connect America Fund Support—their suitability for determining actual cost levels or historic input price time series is very limited.

Shortcomings of the CACM for X-Factor Determination

The CACM is not representative of the predominant technologies used in the provision of price-capped BDS (or the provision of actual LEC service mixes, for that matter), nor has it been demonstrated that the input prices derived from the CACM are representative of those technologies over the time periods used by the FCC for estimating the X-factor. While we have not delved fully into the details of CACM assumptions and model construction, a few high-level observations make it clear that the CACM is ill-suited for use in determining the input price series for a special access X-factor. Quite simply, the CACM was not designed for the purpose to which the FCC is attempting to use it in this proceeding.

As noted above, price-capped BDS are predominantly provided by legacy networks and CACM is primarily designed to provide best-effort mass market broadband. Furthermore, special access services largely provided by legacy TDM technology have guaranteed performance standards and special access configurations are generally idiosyncratic to the locations served. In contrast, the CACM is designed to primarily provide mass-market, best-efforts residential broadband services over a FTTP network.

As noted above, historic series for costs, cost shares and input prices are not generated by proxy models, including the CACM. In the Further Notice, The FCC explains that the input price series for the relevant time frames were determined independently by the Commission staff:

Relying on cost models and industry financial accounts, the Commission staff determined the key cost components of business data services supply, estimated their shares, and estimated changes in the input prices of each key component.²⁷

The FCC claims that there “are no reasons to think” that either the underlying cost categories or rate of change in input prices between the staff-determined forward-looking, least-cost CACM network prices and actual telecommunications network prices should be significantly different.²⁸ However, no proof or evidence supporting this assertion is offered. In fact, the actual provision of special access is much more labor intensive because of the customized, customer-specific nature of these services – which is in marked contrast to the uniform engineering assumptions of mass market services. Indeed, the word “special” in special access is meant to convey the fact that all such circuits are purpose-designed to serve a particular customer location with a level of capacity specifically ordered by that customer on that date. They are not generically designed and preinstalled at all locations within a service area as are mass-market services such as PSTN switched access or BIAS. Furthermore, it is difficult to resolve this unsupported assurance with the seemingly contradictory statement by the FCC noted above that BDS are distinctly different from the services modeled by the CACM and tend to cost “substantially more”:

BDS is distinctly different from the mass marketed, “best efforts” broadband Internet access services (BIAS) provided to residential end users, ... As such, BDS tends to cost substantially more than “best efforts” services and offered to businesses, non-profits, and government institutions that need to support mission critical applications and have greater demands for symmetrical bandwidth, increased reliability, security, and service to more than one location.²⁹

The input prices used in the CACM are largely estimates derived from numerous sources and, thus, have an indeterminate relationship to actual prices.³⁰ Furthermore, it is unclear how a

²⁷ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 408.

²⁸ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 409.

²⁹ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, para 13.

³⁰ For example, in the CACM model documentation, it is stated:

There is no existing readily available source for detailed cost by technology by operating cost category, by geographic area, by density which is aligned with accessible cost drivers. This is the type of information that is needed in a

time series of these proxy prices back to 1997 was established and how these proxies relate to a time series of actual prices over this time period. The only indication of this appears to be an explanation in Appendix C of the Further Notice that for each of the four listed year ranges (i.e., 1997-2015, 1997-2013, 1997-2003, and 2005-2013), “two weighted averages were computed for changes in input prices: one high and one low.”³¹ In our view, this process provides little comfort or assurance that these hypothesized input price series, or their growth, bear any relationship to actual input prices, particularly for the legacy networks that provide the majority of BDS; if anything, it indicates that another level of unverifiable estimates are layered on top of the hypothetical proxy model input prices this approach begins with.

The FCC notes that for the ten CACM cost categories, CostQuest estimated price changes were used for seven categories (fiber, poles, conduit, drop, optical network terminals, fiber pedestals, and splitters), electronics prices were taken from the best estimates in the FCC’s response to peer review, and public sources were used for price changes in labor, real estate, and productivity.³² Furthermore, in its response to the peer review of the CACM (also referred to as “CAM” below) by Professor Hogendorn, the FCC admits these data are limited and of questionable value:

Additionally, other factors suggest the CAM understates costs, for example, because the CAM optimizes costs at a high level, so in general will not account for special circumstances that generally work to raise cost, ...³³

Limited information was available to us on cost movement for the ten cost categories just outlined.³⁴

We do not have good data sources for the history of price changes for the following inputs: fiber, poles, conduit, drop, ONT, fiber pedestal, splitters, and electronics.³⁵

forward-looking modeling effort. Rather, there are a limited number of relevant data points found across an array of information sources. This implies that developing data sources which are inputs into CACM processing will be complex.

See Connect America Cost Model (CACM) Model Methodology, December 22, 2014, p. 27.

³¹ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, Appendix C, para 12.

³² Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, Appendix C, para 7.

³³ Federal Communications Commission, Peer Review of Connect America Phase II Cost Model, FCC Response to Professor Christiaan Hogendorn, p. 3.

³⁴ Federal Communications Commission, Peer Review of Connect America Phase II Cost Model, FCC Response to Professor Christiaan Hogendorn, p. 11.

³⁵ Federal Communications Commission, Peer Review of Connect America Phase II Cost Model, FCC Response to Professor Christiaan Hogendorn, p. 11.

We do not have a price series that could be associated with the cost of land and buildings used in network deployment.³⁶

We do not have any estimates for TFP growth in telecommunications.³⁷

These deficiencies make clear that while these postulated input prices may have been adequate to parameterize a model that is used for allocating a pre-determined total budget of Universal Service support, they are not nearly adequate to bear the weight of providing an accurate calculation of location-specific BDS costs. Thus, relative to the previous standards set by the FCC for price cap regulation, the CACM-based data proposed for establishing the X-factor falls well short of these standards; given the FCC's concern with, and emphasis on, transparency and public availability, we believe these shortcomings are fatal.

Method Three – Connect America Cost Model with TDS Data

Method Three suffers from the same infirmities of Method Two regarding the application of cost proxy models for the purpose of establishing the BDS X-factor. In addition, there is no reason to believe that the input price information supplied by TDS, a largely rural non-price cap LEC, is an improvement over the input price information used in Method Two. Certainly, no proof to this effect has been given. Adding to the uncertainty and potential unreliability of the TDS data are, as noted above, the fact that the TDS cost categories are different than those of the CACM, and the TDS filing that provides its data is heavily redacted.³⁸

SUMMARY OF ASSESSMENT

Of the three methods under consideration by the FCC, the BLS KLEMS method is based on sound economic principles for measuring total factor productivity and, hence, represents the best approach for measuring a special access X-factor. Moreover, with our provided adjustment to the indexing method used, the input prices derived from the KLEMS data represent a consistent and accurate measure of input prices for the industry. As discussed above, there is ample precedent for using an industry-wide measure of TFP for price cap regulation of particular services.

In contrast, the other two proposed methods based on the CACM—a use for which this model was not designed and is ill-suited —produce arbitrary results based on hypothetical networks with a technology and service mix that fails to match that of the price cap LECs actually providing BDS. Neither the input price growth or the measure of TFP growth employed in this approach have been demonstrated to track or even approximate the productivity growth or input price trends of actual telecommunications companies. The only support provided for this

³⁶ Federal Communications Commission, Peer Review of Connect America Phase II Cost Model, FCC Response to Professor Christiaan Hogendorn, p. 12.

³⁷ Federal Communications Commission, Peer Review of Connect America Phase II Cost Model, FCC Response to Professor Christiaan Hogendorn, p. 12.

³⁸ Letter to Marlene H Dortch, Secretary, Federal Communications Commission from Steve Pitterle, Manager - Carrier Relations, TDS Telecommunications Corporation, September 24, 2015.

approach appears to be speculative as it is not at all clear how the various input price time series were developed. The speculative and volatile nature of the two proxy methods is apparent in Table 2, which reproduces the High and Low “Net Impact” (i.e., the combination of input price growth and TFP growth) for Methods 2 and 3 found in Appendix C of the Further Notice, plus a calculation of the range between High and Low Net Impacts. It is evident that the proxy approach produces largely arbitrary and wide-ranging results that call into question the reliability of this method.

Table 2
Wide Range of Net Impact Results Produced by Proxy Methods³⁹

		Method 2	Method 3
		Net Impact	Net Impact
1997-2015	High	-2.26%	-2.93%
	Low	-0.57%	-0.40%
	Range	-1.69%	-2.53%
1997-2013	High	-2.39%	-3.03%
	Low	-0.73%	-0.54%
	Range	-1.66%	-2.49%
1992-2003	High	-3.79%	-4.45%
	Low	-0.70%	-0.43%
	Range	-3.09%	-4.02%
2005-2013	High	-2.26%	-2.93%
	Low	-0.22%	-0.01%
	Range	-2.04%	-2.92%

The integrity and coherence of the data used in these proxy-based approaches must be seriously questioned. We strongly recommend against the use of the CACM-based methods for establishing the special access X-factor.

³⁹ Source: Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, Appendix C, Tables 6 and 7.

APPENDIX: FCC CALCULATION OF INDUSTRY TFP AND INDUSTRY INPUT PRICE TRENDS USING KLEMS

The FCC describes the KLEMS-based method for measuring industry TFP and industry input price trends in Appendix C, of the Further Notice.⁴⁰ In this Appendix we describe how we replicated the calculations done by the FCC, show why the FCC's method used to construct an industry input price index is inconsistent with the methods employed by BLS, and how the BLS constructs an industry input price index that is appropriate for setting the price cap X-factor.

FCC Calculation of the Industry TFP Compound Annual Growth Rate

The FCC calculation is derived from the BLS Multifactor Productivity Index shown in the last column of Table A.1. The term multifactor productivity is synonymous with the term total factor productivity. The compound annual growth rate between year t and year t+n is derived from the formula:

$$\left(\frac{x_{t+n}}{x_t}\right)^{(1/n)} - 1$$

Consequently, the compound annual growth rates for the three year-ranges listed in Table 1 on page 256 are computed as follows:

1997-2013:

$$\left(\frac{98.686}{75.043}\right)^{1/16} - 1 = 1.73\%$$

1997-2003:

$$\left(\frac{74.917}{75.043}\right)^{1/6} - 1 = -0.03\%$$

2005-2013:

$$\left(\frac{98.686}{90.070}\right)^{1/8} - 1 = 1.15\%$$

FCC Calculation of the Industry Input Price Compound Annual Growth Rate

Using an indexing method that lacks economic acceptance, we were able to replicate the computation it made to compute an industry input price index, from which compound annual

⁴⁰ Federal Communications Commission, Tariff Investigation Order and Further Notice of Proposed Rulemaking, WC Docket Nos. 16-143, 15-247, 05-25 and RM-10593, Appendix C, paras 4-6.

growth rates were computed. The computation is based on the price indexes of capital services, labor, energy, materials, and services, found in Table A.2. These price indexes are weighted using the factor shares for capital, labor, energy, materials, and services found in Table A.3. An industry input price index is computed using the following formula:

$$P_t = \sum_{i=K,L,E,M,S} (s_{it} \cdot p_{it})$$

where P_t represents the industry input price index value for year t ; K,L,E,M,S represent the inputs capital, labor, energy, materials, and services, respectively; s_{it} represents the factor share of input i in year t , and p_{it} represents the price index of input i in year t . Thus the industry input price index value for the year 1997 is equal to:

$$P_{1997} = (.380 \cdot 105.977) + (.220 \cdot 46.404) + (.006 \cdot 65.773) + (.053 \cdot 130.135) + (.341 \cdot 81.882) = 85.694$$

The compound annual growth rates for the FCC's industry input price are as follows:

1997-2013:

$$\left(\frac{99.902}{85.694}\right)^{1/16} - 1 = 0.96\%$$

1997-2003:

$$\left(\frac{78.396}{85.694}\right)^{1/6} - 1 = -1.47\%$$

2005-2013:

$$\left(\frac{99.902}{90.832}\right)^{1/8} - 1 = 1.20\%$$

This formula used by the FCC to compute the industry input price index is not a conventional price index accepted in economics, such as the Laspeyres, Paasche, Fisher Ideal, or Tornqvist indices. It is also inconsistent with the method that BLS used to compute price indexes, which is the Tornqvist methodology.⁴¹ In the same table that contains the price indexes for capital services, labor, energy, materials, and services, the BLS computes an industry input price index, which it terms price of combined inputs. Were the FCC to use the BLS industry input price index to compute compound annual growth rates, it would obtain the following results.

⁴¹ One unattractive feature about the FCC formula is that the results are dependent upon the year in which the component price indexes are based. The BLS price indexes are based to 100 in 2009. If those price indexes were rescaled to equal 100 in a different year, the FCC formula would yield different compound annual growth rates. This is not true for the conventional price indexes mentioned above.

1997-2013:

$$\left(\frac{99.195}{79.423}\right)^{1/16} - 1 = 1.40\%$$

1997-2003:

$$\left(\frac{78.092}{79.423}\right)^{1/6} - 1 = -0.28\%$$

2005-2013:

$$\left(\frac{99.195}{90.914}\right)^{1/8} - 1 = 1.10\%$$

Table A.1
BLS Output, Input and Multifactor Productivity Indexes

Table Multifactor Productivity and Related KLEMS Measures from the NIPA Industry Database, 1987 to 2012										
Broadcasting and telecommunications (NAICS 515, 517)										
1 Real Sectoral Output, Input Quantities, and Multifactor Productivity										
2 Indexes = 100.000										
Base Year = 2009										
Year	Sectoral Output	Capital Services	Labor Input	Capital Intensity	Intermediate Inputs	Energy	Materials	Purchased Services	Combined Inputs	Multifactor Productivity
1987	28.316	28.806	96.604	30.343	29.703	N.A.	N.A.	N.A.	39.779	71.184
1988	30.822	30.315	97.330	31.676	31.322	N.A.	N.A.	N.A.	41.425	74.404
1989	31.778	31.764	98.496	32.777	30.026	N.A.	N.A.	N.A.	41.929	75.790
1990	32.696	33.373	98.013	34.585	28.731	N.A.	N.A.	N.A.	42.369	77.170
1991	32.954	34.815	95.956	36.835	28.092	N.A.	N.A.	N.A.	42.778	77.035
1992	34.466	36.592	94.907	39.125	28.225	N.A.	N.A.	N.A.	43.798	78.694
1993	36.463	38.413	96.304	40.453	28.900	N.A.	N.A.	N.A.	45.326	80.446
1994	39.333	40.410	98.175	41.717	30.790	N.A.	N.A.	N.A.	47.482	82.837
1995	42.293	42.723	102.324	42.277	38.648	N.A.	N.A.	N.A.	52.410	80.697
1996	47.022	45.479	105.575	43.573	46.591	N.A.	N.A.	N.A.	57.520	81.749
1997	50.396	48.888	111.325	44.393	63.835	107.878	26.687	75.168	67.155	75.043
1998	55.578	53.108	117.559	45.639	73.657	133.111	30.391	86.803	74.301	74.801
1999	62.544	59.291	124.839	47.943	89.732	209.250	42.852	102.870	85.181	73.425
2000	68.724	68.662	132.977	52.080	101.091	282.134	52.610	113.729	95.452	71.999
2001	69.452	78.419	132.819	59.496	102.207	334.444	50.302	115.414	99.483	69.813
2002	69.610	82.742	121.109	68.779	100.903	243.085	49.027	115.208	97.857	71.135
2003	71.685	82.764	114.297	72.843	99.330	186.384	55.386	111.712	95.685	74.917
2004	76.710	83.333	111.385	75.198	95.766	135.487	62.641	105.284	93.774	81.803
2005	84.100	85.141	108.552	78.730	94.395	116.816	68.244	101.949	93.372	90.070
2006	90.789	88.171	108.430	81.525	99.943	99.827	80.712	105.667	96.787	93.804
2007	95.864	91.998	107.126	86.014	97.302	99.219	89.746	99.450	97.127	98.699
2008	99.890	96.564	104.956	92.072	96.661	103.186	91.902	97.913	98.401	101.513
2009	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
2010	105.032	102.731	95.317	107.721	111.780	97.817	130.900	106.765	104.523	100.488
2011	110.080	105.580	92.597	113.892	126.239	100.963	164.996	116.175	110.625	99.508
2012	114.385	108.648	89.093	121.740	135.225	116.937	181.910	122.998	114.473	99.923
2013	116.794	112.193	88.641	126.289	142.037	113.643	189.387	129.739	118.350	98.686
Source: Bureau of Labor Statistics										
July 28, 2015										
Office of Productivity and Technology										
Division of Major Sector Productivity										

Table A.2
BLS Output and Input Price Indexes

Table Multifactor Productivity and Related KLEMS Measures from the NIPA Industry Database, 1987 to 2012									
Broadcasting and telecommunications (NAICS 515, 517)									
2 Output and Input Prices									
2 Indexes = 100.000									
Base Year = 2009									
Year	Price of Sectoral Output	Price of Capital Services	Price of Labor	Price of Intermediate Inputs	Price of Energy	Price of Materials	Price of Purchased Services	Price of Combined Inputs	
1987	94.869	107.074	31.553	69.462	N.A.	N.A.	N.A.	67.531	
1988	94.184	109.436	33.178	72.921	N.A.	N.A.	N.A.	70.077	
1989	95.650	116.015	32.850	75.322	N.A.	N.A.	N.A.	72.493	
1990	97.399	119.091	34.981	77.619	N.A.	N.A.	N.A.	75.163	
1991	98.690	118.000	36.062	80.151	N.A.	N.A.	N.A.	76.025	
1992	99.176	121.205	37.170	81.891	N.A.	N.A.	N.A.	78.046	
1993	100.293	125.668	39.010	82.996	N.A.	N.A.	N.A.	80.682	
1994	101.012	128.730	42.130	84.998	N.A.	N.A.	N.A.	83.675	
1995	103.611	124.749	44.239	86.039	N.A.	N.A.	N.A.	83.611	
1996	104.394	127.296	45.626	87.172	N.A.	N.A.	N.A.	85.341	
1997	105.837	105.977	46.404	87.567	65.773	130.135	81.882	79.423	
1998	105.471	101.388	49.283	86.775	64.506	122.479	81.794	78.894	
1999	104.254	85.467	54.971	86.987	64.509	115.644	82.764	76.548	
2000	104.695	77.114	57.828	87.522	68.127	110.139	83.935	75.380	
2001	103.713	61.409	63.108	87.545	71.689	103.258	84.683	72.405	
2002	103.794	59.538	70.789	86.999	71.479	101.834	84.238	73.834	
2003	104.238	67.115	75.149	88.313	75.968	100.473	85.793	78.092	
2004	103.931	82.353	79.136	89.891	79.445	100.915	87.492	85.019	
2005	100.937	96.555	77.896	93.046	87.361	102.078	90.890	90.914	
2006	99.861	99.614	78.666	96.811	94.511	104.631	94.827	93.674	
2007	101.015	108.340	90.203	96.666	98.503	103.054	94.963	99.701	
2008	101.409	113.295	91.906	99.184	108.719	102.549	98.138	102.944	
2009	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	
2010	99.548	98.981	99.883	101.148	105.272	98.676	101.855	100.033	
2011	99.213	92.813	102.477	102.369	112.679	97.545	103.863	98.725	
2012	99.934	93.855	104.643	103.153	108.835	94.809	106.119	99.857	
2013	100.516	91.124	106.327	103.283	110.506	92.267	107.316	99.195	
Source: Bureau of Labor Statistics									
Office of Productivity and Technology									
Division of Major Sector Productivity									

Table A.3
BLS Input Cost Shares

Table Multifactor Productivity and Related KLEMS Measures from the NIPA Industry Database, 1987 to 2012							
Broadcasting and telecommunications (NAICS 515, 517)							
5	Factor Shares (Factor Costs Divided by the Value of Production)						
1	Levels						
Year	Capital Factor Shares	Labor Factor Shares	Intermediate Inputs Factor Shares	Energy Factor Shares	Materials Factor Shares	Purchased Services Factor Shares	
1987	0.449	0.258	0.293	N.A.	N.A.	N.A.	
1988	0.447	0.253	0.300	N.A.	N.A.	N.A.	
1989	0.474	0.242	0.284	N.A.	N.A.	N.A.	
1990	0.488	0.245	0.267	N.A.	N.A.	N.A.	
1991	0.494	0.242	0.264	N.A.	N.A.	N.A.	
1992	0.507	0.234	0.258	N.A.	N.A.	N.A.	
1993	0.516	0.233	0.250	N.A.	N.A.	N.A.	
1994	0.512	0.236	0.251	N.A.	N.A.	N.A.	
1995	0.476	0.235	0.290	N.A.	N.A.	N.A.	
1996	0.461	0.223	0.316	N.A.	N.A.	N.A.	
1997	0.380	0.220	0.400	0.006	0.053	0.341	
1998	0.359	0.224	0.416	0.006	0.052	0.358	
1999	0.304	0.239	0.457	0.009	0.062	0.386	
2000	0.288	0.243	0.469	0.011	0.066	0.392	
2001	0.261	0.264	0.474	0.014	0.059	0.401	
2002	0.267	0.269	0.464	0.010	0.057	0.397	
2003	0.291	0.261	0.448	0.008	0.061	0.379	
2004	0.337	0.251	0.412	0.006	0.065	0.342	
2005	0.379	0.226	0.395	0.005	0.067	0.323	
2006	0.379	0.214	0.407	0.004	0.076	0.327	
2007	0.403	0.227	0.371	0.004	0.078	0.288	
2008	0.422	0.216	0.361	0.005	0.076	0.280	
2009	0.391	0.227	0.382	0.004	0.082	0.296	
2010	0.380	0.207	0.413	0.004	0.101	0.307	
2011	0.351	0.197	0.452	0.004	0.121	0.327	
2012	0.349	0.185	0.466	0.005	0.124	0.338	
2013	0.341	0.182	0.477	0.005	0.122	0.351	
Source: Bureau of Labor Statistics							
Office of Productivity and Technology				July 28, 2015			
Division of Major Sector Productivity							